CLAIMS

What is claimed is:

[0140] [Note: **Bold** bracketed ***and size-reduced*** **cross-referencing text** (e.g., [123]) is provided in the below claims as an aid for readability and for finding corresponding (but not limiting) examples of support in the specification. The bracketed text is not intended to add any limitation whatsoever to the claims and should be deleted in all legal interpretations of the claims and should also be deleted from the final published version of the claims.]

1. A combination of a fork-liftable refuse container [302] and a side-loading robotic arm mechanism [350] for use with a front-loading, waste collecting vehicle [301], where the vehicle has frontwardly extending forks [132] and where said combination is characterized by:

(a) the side-loading robotic arm mechanism having a major portion of its mass [350'] mounted rearward of a rear, refuse-containing wall [402b] of the fork-liftable container; and

(b) the container having fork-receiving pocket means [402a,402a"] attached to sides of the container for receiving the forks of a front-loading vehicle, where the fork-receiving pocket means extend or are extendible rearwardly of said rear refuse-containing wall of the container so as to space the rearward-mounted major-mass portion [450b] of the robotic

arm mechanism in front of a hypothetical clearance plane [432a], where the clearance plane extends through rear end points of the forks of the front-loading vehicle.

2. The combination of Claim 1 and further wherein:

(c) a protective cage [360,460] is provided extending about at least a portion of the rearward-mounted major-mass portion [450b] of the robotic arm mechanism so as to protect the rearward-mounted portion from short dump or other rear-side collisions.

3. The combination of Claim 2 and further wherein:

(c.1) the protective cage includes a first protective crossbar [460a] extending from a left side to a right side of the fork-receiving pocket means [402a,402a"] .

4. The combination of Claim 3 and further wherein:

(c.2) the protective cage includes a second protective bar [460b] extending in a direction different than the extension direction of the first protective crossbar.

5. The combination of Claim 3 and further wherein:

(c.3) at least one of said first protective crossbar [460a] and second bar [460b] has an elastomeric bumper attached thereto.

6. The combination of Claim 1 and further wherein:

(b.1) the fork-receiving pocket means [402a"] includes a vibration dampener [403] interposed between a fork-engaging portion [404] and a container-supporting portion [405] of the fork-receiving pocket means.

7. The combination of Claim 1 and further wherein:

(b.1) the fork-receiving pocket means [402a"] includes one or more support ribs [402g] disposed rearward of the rear, refuse-containing wall [402b] of the fork-liftable container.

8. The combination of Claim 1 and further wherein:

(c.1) the fork-liftable container includes a rearward-extending support member [402e"] which extends rearwardly from a main body portion of the container and provides mechanically reinforcing support at least to corresponding portions of the fork-receiving pocket means which extend rearwardly of the rear, refuse-containing wall [402b].

9. The combination of Claim 1 and further wherein:

(a.1) the rearward-mounted major-mass portion [450b] of the robotic arm mechanism includes at least a first motor [452,My] for mechanically driving sideways translation of a corresponding robotic arm so as to provide for reaching out to grasp waste items located to the side of the container.

10. The combination of Claim 9 and further wherein:

(a.2) the rearward-mounted major-mass portion [450b] of the robotic arm mechanism further includes a second motor [453,MΦ] for mechanically driving rotation of the corresponding robotic arm for translating grasped waste items along an arc-shaped path [Fig.2D] which extends to over a top portion of the fork-liftable container.

11. The combination of Claim 10 and further wherein:

(a.3) the rearward-mounted major-mass portion [450b"] of the robotic arm mechanism further includes a third motor [451"MG] for mechanically driving grasping by the corresponding robotic arm of to-be-grasped waste items.

12. The combination of Claim 10 and further wherein:

(a.3) the rearward-mounted major-mass portion [450b"] of the robotic arm mechanism further includes a third motor [454] for mechanically driving retractable lowering of a corresponding, retractable leg for retractable engagement with a support surface below the robotic arm mechanism.

13. A robotic waste collecting apparatus comprising:

(a) a fork-liftable refuse container [402] for use with a front-loading, waste collecting vehicle [301], where the vehicle has frontwardly extending forks [132], where the container has front and rear, refuse-containing walls [402f,402b]; and

(b) a side-loading robotic arm mechanism, coupled to the container and having

one or more robotic arms [351,551] each configured to automatically reach out in a sideways direction relative to the container to grasp waste items located to the side of the container, and to translate the grasped waste items for automatic deposit of refuse portions thereof into the container; and further wherein:

(b.1) the robotic arm mechanism has a plurality of motors [451-453] for mechanically driving at least the reaching-out, grasping and further translating actions of said one or more robotic arms, and at least two [452,453] of said plural motors are mounted rearward of the rear, refuse-containing wall [402b] of the container.

14. The robotic waste collecting apparatus of Claim 13 and further wherein:

(b.1) the container has fork-receiving pocket means [402a,402a"] attached to sides of the container for receiving the forks of the front-loading vehicle, where the fork-receiving pocket means extend rearwardly of said rear refuse-containing wall of the container so as to space the rearward-mounted motors [452,453] of the robotic arm mechanism in front of a hypothetical clearance plane [432a], where the clearance plane extends through rear end points of the forks of the front-loading vehicle when the forks are fully inserted into the pockets.

15. The robotic waste collecting apparatus of Claim 14 and further wherein:

(b.2) the fork-receiving pocket means [402a"] includes a vibration dampener [403] interposed between a fork-engaging portion [404] and a container-supporting portion [405]

of the fork-receiving pocket means.

16. A method for reducing transfer of mechanical vibrations between a front-loading, waste collecting vehicle [301] and a combination of a fork-liftable refuse container [302] and a side-loading robotic arm mechanism [350] , where the vehicle has frontwardly extending forks [132] for supporting said combination of the container and the side-loading robotic arm mechanism; said vibration reducing method comprising:

(a) situating a majority of mass [350'] of the side-loading robotic arm rearwardly of a rear, refuse-containing wall [402b] of the container;

(b) providing the container with fork-receiving pocket means [402a,402a"] attached to sides of the container for receiving the forks of the front-loading vehicle; and

(c) providing clearance assuring means on the fork-receiving pocket means or elsewhere for spacing the rearwardly-mounted major-mass portion [450b] of the robotic arm mechanism in front of a hypothetical clearance plane [432a], where the clearance plane extends through rear end points of the forks of the front-loading vehicle when the forks are operatively inserted in the fork-receiving pocket means.

17. The vibration reducing method of Claim 16 and further comprising:

(d) including in the fork-receiving pocket means [402a"] , a vibration dampener [403] interposed between a fork-engaging portion [404] and a container-supporting portion [405] of the fork-receiving pocket means.

18. A method for simultaneously collecting waste items [509a-509c] situated on opposed sides of a driveway [507a-507b] , the method comprising:

(a) providing a combination of a fork-liftable refuse container [502] and a side-loading robotic arm mechanism [350',550] , where the robotic arm mechanism has at least first and second robotic arms [351,551] each configured to automatically reach out in a respective sideways direction relative to the container to grasp waste items located to the respective side of the container, and to translate the grasped waste items for automatic deposit into the container; where the first robotic arm is mechanically coupled to the container and configured to reach out in a first sideways direction, and where the second robotic arm is mechanically coupled to the container and configured to reach out in an opposed second sideways direction; and

(b) selectively actuating each of the first and second robotic arms while driving in a given direction along the driveway so as to automatically grasp waste items situated on the opposed sides of the driveway.

19. The collection method of Claim 18 and further comprising:

(c) providing the multi-arm robotic arm mechanism with a plurality of motors [451-453] for mechanically driving at least the reaching-out, grasping and further translating actions of said first and second robotic arms, and situating at least two [452,453] of said plural motors rearward of the rear, refuse-containing wall [402b] of the container.

20. A waste collecting system [400,600] comprising:

(a) a fork-liftable, waste-containerizing vessel [402,602] having spaced-apart, front and back waste-retaining surfaces [402f,402b], where a waste-containment space is defined between the front and back waste-retaining surfaces;

(b) a waste-grasping robot [450,650] provided adjacent to the vessel and adapted to move waste [309b] external of the vessel into the waste-containment space, said vessel and robot being movable as a unit on a supplied fork lift means [632], said robot having one or more motor means [451-453] for outputting mechanical power enabling the robot to move the waste, said robot having a retractable grasping arm [451a] for enabling the robot to move the waste, said robot having a total mass comprised at least of masses of said one or more motor means and of the retractable grasping arm; and

(c) an interface [457a,657a];

where a major portion of the total mass of the robot is located between said interface and the back waste-retaining surface [402b] , and

where the interface comprises one or more elements of the interface group consisting of:

(c.1) a power source coupling can be coupled to a power source [127] to provide power to one or more of said motor means;

(c.2) a robot controller [311a] operatively coupled to a respective one or more of the motor means for controlling actions taken by the respective one or more of the

motor means;

(c.3) disconnectable hydraulic connection means for operatively coupling a respective one or more of the motor means to a hydraulic power source [127]; and

(c.4) transport movement controlling means [128,133] for controlling movement as a unit of the fork-liftable, waste-containerizing vessel and of the waste-grasping robot.

21. The waste collecting system [400,600] of Claim 20 wherein the major portion of the total mass of the robot is located between said back waste-retaining surface [402b] and at least one of a:

(c.5) a transparent windshield through which an operator can view operations of the robot;

(c.6) a pair of lift arms [132] which support the weight of the vessel and robot;

(c.7) a pair of fork pistons [133] which are operatively coupled to pitch as a unit, the combination of the fork-liftable, waste-containerizing vessel and the waste-grasping robot; and

(c.8) a waste collecting vehicle [101,301].

22. A waste collecting system comprising:

(a) a fork-liftable, waste-containerizing vessel having spaced-apart, front and rear waste-retaining side surfaces, where a waste-containment space is defined between the front and rear waste-retaining side surfaces, and

(a.1) where the vessel has fork-receiving pockets [402a] adapted to receive lifting forks [432] introduced from the rear side of the vessel, where at least one of the pockets does not extend frontwardly up to or beyond the front waste-retaining side surface [402f] of the vessel; and

(b) a waste-grasping robot [450] provided adjacent to the vessel and adapted to move waste external of the vessel into the waste-containment space, said vessel and robot being movable as a unit while supported by forks [632] introduced into the fork-receiving pockets; said robot having one or more motor means [451-453] for outputting mechanical power enabling the robot to move the waste, said robot having a retractable grasper [451a] for enabling the robot to move the waste, said robot having a total mass comprised at least of masses of said one or more motor means and of the retractable grasper,

(b.1) where a major portion of the total mass of the robot is located rearward of the rear waste-retaining side surface [402b] of the vessel.

23. The waste collecting system of Claim 22 and further wherein:

(a.2) at least one of the fork-receiving pockets extends or is extendible rearwardly at least 10 inches beyond the rear waste-retaining side surface [402b] .

24. The waste collecting system of Claim 22 and further comprising:

(c) spacing means [432c,b;402i] for keeping the major mass portion [450b] of

the robot disposed forward of a hypothetical clearance plane [432a] where said hypothetical clearance plane extends substantially parallel to the rear waste-retaining side surface [402b] of the vessel when the vessel is substantially level to ground during a waste collecting run, the spacing provided by said spacing means assuring a predefined clearance space in which the retractable grasper [451a] and one or more of the motor means may operate during the waste collecting run without encountering an obstacle [433].

25. The waste collecting system of Claim 22 and further comprising:

(c) a bumper pad [460e] adjacent to the rear waste-retaining side surface [402b] of the waste-containerizing vessel so as to absorb mechanical shocks directed frontwardly toward the rear waste-retaining side surface.

26. A waste collecting system comprising:

(a) a fork-liftable, waste-containerizing vessel having spaced-apart, front and back waste-retaining side surfaces, where a waste-containment space is defined between the front and back waste-retaining side surfaces;

(b) a waste-grabbing robot provided adjacent to the vessel and adapted to move waste external of the vessel into the waste-containment space, said vessel and robot being movable as a unit when supported by a supplied fork lift means; said robot having one or more motor means for outputting mechanical power enabling the robot to move the waste, said robot having retractable grasping digits

[451a] for enabling the robot to move the waste, said robot having a total mass comprised at least of masses of said one or more motor means and of the retractable grasping digits, where a major portion of the total mass of the robot is located rearward of the rear waste-retaining side surface of the vessel; and

(c) a bumper means [460e] disposed adjacent to the rear waste-retaining side surface of the waste-containerizing vessel so as to absorb mechanical shocks directed frontwardly toward the rear waste-retaining side surface.

27. A manufactured combination [300] comprising:

(a) a container [302] having front and rear sides and fork receiving means [320a] for receiving supplied lifting forks [332] inserted frontwardly [+X] from the rear side of the container;

(b) a robot [350] with a substantial part of its mass positioned rearwardly of the rear side of the container; and

(c) instruction means [311b] directed to said container and robot and including instructions for inserting the supplied lifting forks frontwardly from the rear side of the container.

28. The manufactured combination of Claim 27 wherein the instruction means includes one or more of:

(c.1) manufactured signals from a network site;

(c.2) machine-generated audio signals; and

(c.3) human-readable indicia on an indicia carrying medium.

29. A method for using a robot-assisted waste collecting system [300] where the system has a container [302], a user interface [311a] and a waste-fetching and disposing robot [350], where a major portion [450b] of the mass of said robot is interposed between said user interface and said container, the method of using comprising:

(a) inserting lifting forks [332] frontwardly from the rear side of the container for supporting on the inserted forks, at least the weight of the container, the weight of the robot, and the weight of waste [303] fetched by the robot and disposed by the robot into the interior of the container.

30. The method of Claim 29 and further comprising:

(b) operatively coupling the combination of said container and robot to a vibration dampening means [314] .

31. A mechanically-liftable combination of a refuse container [702] and a side-loading robotic arm mechanism [750] for use with a front-loading, waste collecting vehicle [301], where the vehicle has a frontwardly facing engagement means [739,732] for disengageably engaging with and mechanically lifting the combination

of the refuse container and the robotic arm mechanism, the engagement means including a fork-free means [739] for disengageably engaging with and mechanically lifting the combination, and where said combination is characterized by:

(a.1) the side-loading robotic arm mechanism having a major portion of its mass [750] positioned rearward of a position where a rear, refuse-containing wall [402b] of the container [702] is or will be positioned;

(a.2) the side-loading robotic arm mechanism having a retractable side arm [751,752] for retractably reaching out to grab side-situated waste [309a,309b] and for translating the grabbed waste towards a location where the refuse container is or will be situated during waste collection;

(b) the combination having lift-receiving means [759,701a,703a] for operatively receiving the frontwardly facing engagement means of a provided, front-loading vehicle; and

(c) the combination having or being adapted to engageably cooperate with clearance means [701b] for helping to keep the rearwardly positioned, major mass portion of the robotic arm mechanism clear of collision with one or more parts of the provided, front-loading vehicle during at least one of a first operation where the refuse container [702] is mechanically lifted [102"] for dumping of its contents and a second operation where the retractable side arm is reaching out to grab side-situated waste.

32. The mechanically-liftable combination of Claim 31 wherein:

(a.1a) the major mass portion of the side-loading robotic arm mechanism includes

at least a first motor [M_Y] for causing sideways reciprocation [Y-direction] of a grasper portion [751] of the robotic arm mechanism.

33. The mechanically-liftable combination of Claim 32 wherein:

(a.1b) the major mass portion of the side-loading robotic arm mechanism includes at least a second motor [M_θ] for causing upwards rotation [θ-direction] of the grasper portion [751] of the robotic arm mechanism.

34. The mechanically-liftable combination of Claim 33 wherein:

(a.1c) the major mass portion of the side-loading robotic arm mechanism includes at least a third motor [M_G 451"] for causing a grasping action to be carried out by the grasper portion [751] of the robotic arm mechanism.

35. The mechanically-liftable combination of Claim 33 wherein:

(a.1c) the major mass portion of the side-loading robotic arm mechanism includes at least a third motor [M_Φ] for causing lateral rotation [Φ-direction] of the grasper portion [751] of the robotic arm mechanism.

36. The mechanically-liftable combination of Claim 31 wherein:

(b.1) the lift-receiving means includes an A-frame style, receiving pocket [759].

37. The mechanically-liftable combination of Claim 36 wherein:

(b.2) the lift-receiving means further includes a fork-receiving pocket [701a].

38. The mechanically-liftable combination of Claim 31 wherein:

(c.1) the clearance means includes a protective cage [701b] provided adjacent to the rearwardly positioned major mass portion [750] of the side-loading robotic arm mechanism for protecting the major mass portion from accidental collision with the provided, front-loading vehicle.

39. The mechanically-liftable combination of Claim 31 and further comprising:

(d) an interface means [757a] for interfacing with electrical, hydraulic or other operation energizing means of the provided, front-loading vehicle;

(a.3) wherein the major mass portion [750] of the side-loading robotic arm mechanism is interposed between said interface means [757a] and location where the refuse container is or will be situated during waste collection.

40. A modularly-assembleable, waste-collecting structure [701,703] for use with a front-loading, waste collecting vehicle [301], where the vehicle has a frontwardly facing engagement means [739,732] for disengageably engaging with and mechanically lifting a counterpart, engageable refuse container [102]; said modularly-assembleable, waste-collecting structure comprising:

(a) rearward-mounting enabling means [402a,601,701] for enabling a major-mass portion [750] of a robotic arm mechanism to be detachably mounted rearward of a detachable or fixedly co-attached intermediate container [702] and/or rearwardly of a detachable or fixedly co-attached, container-supporting frame [703] such that one or more associated robotic graspers [751] and associated arm mechanisms [755] of the robotic arm mechanism can unobstructedly carry out reach-out and waste-capturing operations and retract and waste-dumping operations while the major-mass portion is in the rearward-mounted position interposed between the waste collecting vehicle [301] and one or both of the detachable or fixedly co-attached intermediate container [702] and, if any, the detachable or fixedly co-attached, container-supporting frame [703] .

41. The modularly-assembleable, waste-collecting structure of Claim 40 and further comprising:

(b) detachable-engagement receiving means [759,601a] for allowing the major-mass portion and its associated robotic graspers and arm mechanisms to be supported, together with the weight of grasped waste if any, by one or more retractably-insertable forks [732] and/or other detachably-engageable support and translating means [739] such that the associated grasper and arm can safely and unobstructedly carry out reach-out and waste-capturing operations and retract and waste-dumping operations while the major-mass portion is in the rearward-mounted position.

42. The modularly-assembleable, waste-collecting structure of Claim 40 and further comprising:

(b) detachably-couplable power/control means [757a] for allowing the major-mass portion to safely receive and/or forward hydraulic, electrical and/or other forms of empowering energy and/or to safely receive and/or forward electromagnetic and/or other forms of control signals for allowing the associated robotic arm mechanism to safely carry out corresponding reach-out and waste-capturing operations and retract and waste-dumping operations while the major-mass portion is in the rearward-mounted position and to allow the major-mass portion to be easily decoupled from its power and/or control signal sources [311a] when the major-mass portion is to be detached from the waste-collecting vehicle [301'] or other, alike transporting and empowering means.